

*Preliminary Account of the Habits and Structure of the
Anaspididæ, with Remarks on some other Fresh-water
Crustacea from Tasmania.*

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[PLATE 13.]

In 1893, Mr. G. M. Thomson* described an interesting Schizopod from a small pool near the summit of Mount Wellington, which he named *Anaspides tasmanicæ*, and pointed out many peculiarities in its organisation, tending to show the primitive character of the animal.

Dr. W. J. Calman,† in 1897, revised Thomson's description and instituted a comparison between Anaspides and certain Carboniferous shrimps of Europe and North America (*Gampsonyx*, *Palæocaris*, etc.), and, in a later paper dealing with the classification of the Malacostraca as a whole, this author proposes to do away with the order Schizopoda altogether, and to redistribute its component families, uniting the Mysidacea with the Amphipoda, Isopoda, and Cumacea in a division, Peracarida, placing the Euphausiacea with the Decapoda in a division, Eucarida, while Anaspides constitutes a division, Syncarida, by itself.‡

The chief distinguishing features of the Peracarida are the incomplete nature of the carapace, the presence of a brood pouch in the female, formed from oostegites on the thoracic limbs, the elongated heart, the few and simple hepatic cœca, filiform spermatozoa, and direct development without complicated metamorphoses. The Eucarida show the exact converse of these characters.

From what was known of Anaspides, it seemed doubtful if it could be placed in either of these sub-classes, since although it was without a carapace, it appeared to possess no trace of a brood pouch. Quite recently, Mr. O. A. Sayce§ has described a remarkable fresh-water crustacean from the neighbourhood of Melbourne, which is evidently closely allied to Anaspides in its general structure, but it presents the curious feature of possessing sessile eyes, a

* 'Linn. Soc. Trans.,' 2nd ser., vol. 6, 1894—97, Part 3, August, 1894, pp. 285—303, Plates 24—26.

† 'Roy. Soc. Edin. Trans.,' vol. 38, Part 4, 1896, pp. 787—802, Plates 1 and 2.

‡ 'Ann. Mag. Nat. Hist.,' 7th ser., vol. 13, 1904, p. 144.

§ 'Victorian Naturalist,' vol. 24, p. 117, 1907.

character which makes it all the more difficult to preserve the Schizopoda as a natural group.

The observations which I have to offer upon the Tasmanian Anaspididæ both in respect of their habits in a natural state and of their anatomy, will, I believe, confirm the desirability of following Calman's classification in doing away with the Schizopoda as a natural group, and certainly of placing the Anaspidacea in a separate division.

I have also to report the discovery of a new genus and species of the Anaspididæ from the Great Lake of Tasmania, which I propose to name *Paranaspides lacustris*, so that at the present time, not counting possible fossil allies, three types of the Anaspidacea are known, viz., *Anaspides tasmanica* (Thomson) and *Paranaspides lacustris* (Smith), from Tasmania, constituting the family Anaspididæ, and *Koonunga cursor* (Sayce), representing a separate family, Koonungidæ, from southern Victoria.

Anaspides tasmanica (Thomson).

Habits and Occurrence.—During an expedition to Tasmania, which I was enabled to undertake through the assistance of Professor G. C. Bourne and the British Association, four localities were established where the shrimp occurred: (1) in isolated pools and in the pools of the upper part of the North-west Bay River as it leaves the table-land on the top of Mount Wellington; (2) some large tarns near the summit of the Harz Mountains to the south-west of Hobart; (3) the tarns and mountain streams near the top of Mount Field to the north-west of Hobart; (4) in the tarns near Mount Read on the west coast. The animal, therefore, appears to be confined to the southern and western part of the island, and it is always found at a high elevation of 2000—4000 feet, in ice-cold water of absolute clarity.

The body of a very large specimen may measure 2 inches in length, and the yellowish skin is deeply pigmented with black chromatophors. There is no calcification in the exoskeleton, though small deposits of lime are present round the thoracic ganglia.

The animal pursues a creeping habit, walking about on the rocks and among the vegetable growths at the bottom of the pools; occasionally it swims lazily in the water, and on reaching the surface may turn over on its back, like a Phyllopod. When disturbed, it gives rapid side-strokes with the abdomen and tail fan, which drive it *forwards* or sideways; it never springs backwards, as so many Malacostraca do. The most interesting point about the creature in its natural state is that the body is held quite flat and unflexed, with the walking thoracic legs and abdominal pleopods, which also

assist the walking movement, spreading out laterally from the body in the position shown in fig. 1 (Plate 13).

This unflexed posture, besides giving a very unshrimp-like appearance to the animal, is important, because the Carboniferous fossils referred to above are generally preserved in this condition, showing that they probably followed a similar habit of life.

Anaspides appear to be omnivorous, as they will feed upon the dead bodies of insect larvæ or even upon one another; but their chief food is the algal slime covering the rocks among which they live, and they also browse upon the shoots of submerged mosses and liverworts.

There is a point in regard to the function of the exopodites of the thoracic limbs which can only be observed in the living animal, and has been missed by previous authors; these exopodites are not locomotory in function, but are kept in a continual waving motion even when the animal is stationary, and serve to keep up a current of fresh water round the gills. Their function appears to be entirely respiratory.

All the numerous specimens observed appeared to be entirely free from any parasites, and the only native fish inhabiting the waters where it occurs is the little Mountain Trout (*Galaxias truttaceus*), which is probably not a formidable enemy. The introduced English trout, however, which are multiplying so rapidly in the Tasmanian rivers and lakes will probably end by exterminating the shrimp.

Anatomy.—There is very little to add to the descriptions that have been given of the external anatomy and form of the appendages, except in relation to the genital openings, which were erroneously described by Thomson. Both the male and female openings are in the normal Malacostracan position, *i.e.*, the vasa deferentia open at the bases of the last pair of thoracic legs, and the oviducts at the bases of the last pair but two. The large median opening on the ventral surface of the last thoracic segment in the female is not, as Thomson supposed, the aperture of the oviducts, but opens into a blind pouch, the spermatheca, where the male deposits the spermatozoa. This spermatheca is unparalleled in other "Schizopoda," and seems to point to Decapodan affinities.

The internal anatomy, studied in fresh material and by means of serial sections, reveals several points of importance.

The *heart*, which is tubular and elongated, stretches through the whole of the thorax, and passes without a very definite constriction into the abdomen. The ostia, of which there are apparently only a single pair, are situated in a constriction in the third thoracic segment. The structure of the heart recalls very closely that of the Mysidacea.

The *alimentary canal* is furnished with a gastric mill of a simple character, provided with numerous ridges and setæ; behind the stomach enter about thirty long, slender, and unbranched cœca of a glandular nature ("liver"). In the abdominal region, two dorsal unpaired cœca of a small size are present, which are difficult to compare with similar structures in the Decapoda, owing to the backward position of the anteriorly placed cœcum. The whole structure of the alimentary canal is peculiar, and not quite like that of any other group of the Crustacea.

The *ovaries* and *testes* are paired tubes stretching the whole length of the body. Their ducts are simple tubes not provided with accessory glands. The adult spermatozoa are filiform, with globular heads and an elongated flagellum, an important diagnostic character shared in common with the Mysidacea.

The *excretory glands* are large coiled tubes ending in an expanded sac and opening at the bases of the second maxillæ. No antennary glands are present.

The presence of maxillary glands, which are characteristic of the Entomostraca, must be looked upon as a primitive character; but it occurs in a few instances among the Isopoda as well. The *nerve-cord* consists of eight free thoracic ganglia, corresponding to the eight free thoracic segments, and six abdominal ganglia. The definite discovery that there is a free thoracic ganglion corresponding to the first thoracic segment is of some importance, since doubt has been thrown upon the real segmental value of this segment, which in all other Malacostraca is definitely fused with the head.

Breeding Habits.—Since there is no trace of a brood pouch, it was of interest to establish what the female does with her eggs, especially as this is a character of great taxonomic importance. The male deposits two very large spermatophors in the spermatheca of the female; these spermatophors are curved structures, and project outside the spermatheca. The spermatozoa pass into the spermatheca, and the spermatophors drop off. The eggs, which are pale purple in colour and measure about a millimetre in diameter, are passed out of the oviducts, and probably are fertilised as they pass out by spermatozoa, which migrate from the spermatheca, and possibly they are assisted in this migration by the setose projections on the internal faces of the coxopodites of the last three pairs of thoracic appendages, these projections being a sexual character confined to the female.

The female deposits and hides her eggs singly, and not agglutinated together, under stones and among the roots of water plants, being the only crustacean with the exception of the peculiar parasitic Argulidæ to do this.*

* Certain Euphausiidæ also deposit their eggs, but not the family as a whole.

This habit of depositing the eggs, which separates Anaspides from all the other groups of the Malacostraca, is probably primitive, and it emphasises very strongly the isolation of the Anaspidacea from the other Malacostraca, all of which have the most constant and elaborate way of carrying the eggs, involving radical modifications of structure, none of which the Anaspidacea possess.

I was unable to observe the hatching out of the eggs, but the whole of the evidence I could bring together combines to show that the young hatch out with the essential if not identical structure of the adult.

Systematic Position.—The characteristics of Anaspides may be summarised in the form of a table setting forth those characters in which it is peculiar, and those in which it agrees with the other divisions of the Malacostraca in separate columns:—

Peracaridan. (Mysidacean.)	Eucaridan. (Decapoda.)	Peculiar features.
Absence of carapace. Structure of heart. Filiform spermatozoa.	Auditory organ on first antennæ. Modification of endopodites of first two pleopods as copulatory organs, and presence of spermatheca. Absence of lacinia mobilis on mandible.	Eight free thoracic segments with eight ganglia corresponding. Oviposition. Maxillary gland. Structure of alimentary canal. Plate-like structure of the double series of gills.

This table will serve to demonstrate the impossibility of including Anaspides in either the Peracarida or Eucarida, and since to include it in the old group Schizopoda would further stretch the bounds of that already heterogeneous collection, it seems desirable to adopt Calman's term, Syncarida, for a division to include Anaspides and its allies, both living and extinct.

Those characters which Anaspides does not possess peculiar to itself are shared either with the Mysidacea or else with the Decapoda, so that I am unable to follow Thomson and Sayce in finding special Euphausiid affinities. The resemblance to the Euphausiacea only concerns details in the structure of the appendages and cannot compare in importance with such characters as the elongated heart and the filiform spermatozoa which are actually diagnostic of the Mysidacea. The fact that the Anaspidacea seem to skip over the Euphausiacea and to link themselves more directly to the Decapoda would suggest that the Euphausiacea do not stand in the direct line of Decapodan descent, but have been secondarily derived from a primitive Decapod type by the loss of certain important characters, *e.g.*, the auditory organs on the second antennæ.

Paranaspides lacustris.

This type of a new genus of the Anaspididæ was found by me in the Great Lake on the central plateau of Tasmania at an elevation of 3700 feet. It inhabits the littoral zone of the lake, living among the rocks and water-weeds rather after the manner of a prawn. It is totally different in external appearance to Anaspides, being of a green transparent colour sparsely powdered with black dots, and the body exhibits a marked dorsal flexure very much as in Mysis, to which it bears an extraordinary superficial resemblance (fig. 2, Plate 13).

The largest specimen obtained was about an inch in length. It pursues a swimming habit, with which is correlated the flexure of the body, the elongation of the abdomen, the enlarged tail fan, and the enlarged scales on the second antennæ (figs. 3 and 4).

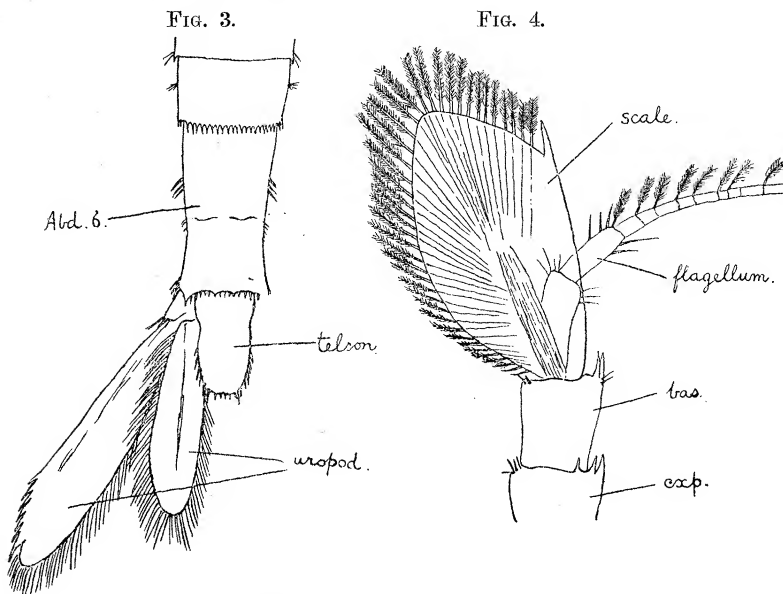


FIG. 3.—*Paranaspides lacustris*. Hind part of body, dorsal view. Abd. 6, sixth abdominal segment.

FIG. 4.—*Paranaspides lacustris*. Second antenna, dorsal view; bas., basipodite; cxp., coxopodite.

Besides these characters distinguishing it from Anaspides, important differences exist in the structure of the mandible, which bears a four-jointed and distinctly biramous palp (fig. 5), a character only found elsewhere in Crustacea among the Copepoda, while the first thoracic appendage bears on the inner face of the antepenultimate joint a setose lobe used in mastication (fig. 6).

FIG. 5.

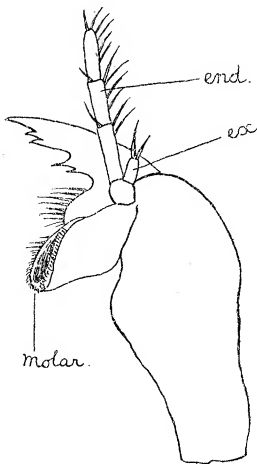


FIG. 6.

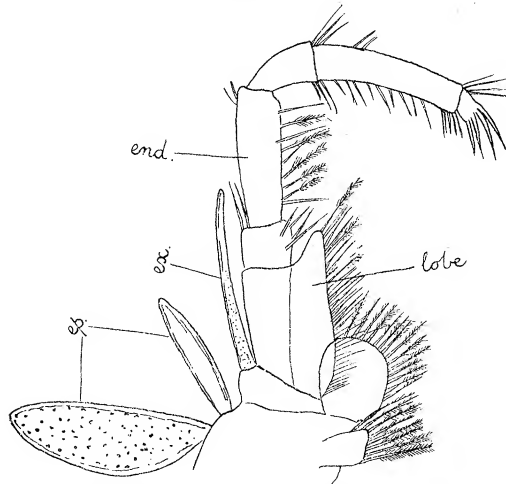


FIG. 5.—*Paranaspides lacustris*. Left mandible, inner view. *end.*, endopodite of palp; *ex.*, exopodite.

FIG. 6.—*Paranaspides lacustris*. First thoracic appendage. *end.*, endopodite; *ex.*, exopodite; *ep.*, epipodites; *lobe*, additional lobe on ischiopodite.

In all other essentials the structure agrees with that of Anaspides.

Associated with *Paranaspides lacustris* in the Great Lake was a very abundant development of ground-living Crustacea, including several Amphipods (*Neoniphargus* and *Chiltonia*), and three or four apparently new species of the peculiar Australian and New Zealand genus *Phreatoicus*, curious Isopods of a very generalised nature. One of these species was a handsome spiny form with orange-coloured antennæ and limbs, attaining about an inch in length.

The extremely abundant development of this Crustacean fauna in the littoral zone of the Great Lake was very striking, and it seems probable that it furnishes an important part of the food for the imported English brown trout, which in this lake may attain to the enormous weight of 25 lbs. A dissection of the stomachs of several trout revealed the fact that they had been feeding upon these creatures.

The Anaspidae and Phreatoicidae of Southern Australia and Tasmania really stand in much the same relation to other Crustacea as the Monotremata do to normal mammals, and it is of interest to enquire whence these peculiar Crustacea have been derived, and how it comes about that they are now restricted to this isolated corner of the Antipodes. The most striking thing about their distribution at the present time is the fact that not only are they absolutely confined to the temperate parts of the Australasian region, but

also to the coldest parts of the temperate zone, the majority of the Anaspidacea and Phreatoicidæ being found at considerable elevations on mountain ranges which are covered with snow for at any rate a great part of the winter. They are absolutely unknown from Australia north of the Dividing Range.

A great deal of evidence has accumulated in recent years supporting the theory of the existence, perhaps in very early Tertiary times, of an Antarctic continent, affording means of communication between Southern Australia, South America, and to a less extent with New Zealand, upon which the characteristically temperate part of the fauna and flora now found, with many elements shared in common in these countries, was largely developed. The greatest community exists now between temperate Southern Australia and South America, the connection with New Zealand being apparently more ancient.

If this Antarctic Continent really existed, it is fairly certain that the Anaspidacea and Phreatoicidæ, being not only temperate but alpine in their habitat, formed a part of its fauna; we should therefore be justified in expecting the discovery of these creatures or nearly related forms in temperate South America, especially as the Phreatoicidæ have already been found in New Zealand.

[*Note added while the paper was passing through the press.*—Certain other Crustacea that were commonly met with in the fresh-waters of Tasmania, especially in the highlands, have closely related forms in New Zealand and South America. Thus the Amphipod *Chiltonia australis* is exceedingly common in Tasmania, the genus being represented in South Victoria and New Zealand, and replaced in South America by the closely-related *Hyaletella*. The commonest element in the plankton of the lakes and tarns of Tasmania is afforded by various species of the Copepod genus *Bæckella*, which entirely replaces the northern *Diaptomus*. *Bæckella* occurs again in New Zealand and temperate South America, but is unknown in the northern hemisphere. Other species of fresh-water Crustacea are closely related to forms in the northern hemisphere, but it seems very probable that they have reached Tasmania and Southern Australia *viâ* South America and the Antarctic continent. Such are the genera *Neoniphargus* and *Gammarus*, which are unknown in the tropics, and confined in their distribution to the temperate northern hemisphere and to temperate Australasia. The small planktonic genus *Bosmina*, which is widely distributed over the northern hemisphere and descends right down the Andes to temperate South America, was found by me as a common constituent of the plankton of the highland lakes in Tasmania. The genus

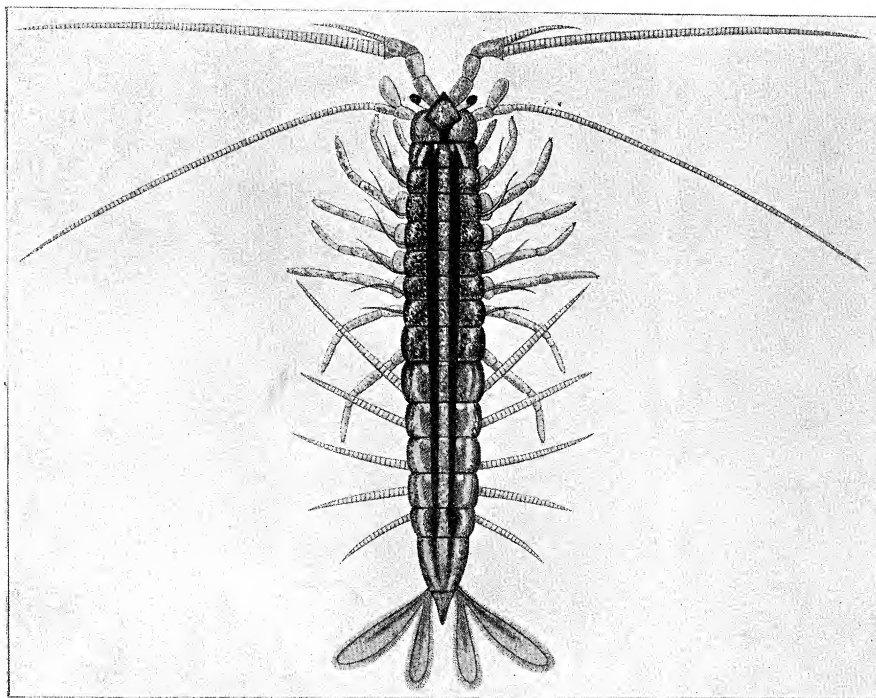


FIG. 1.—*Anaspides tasmanica*. Nat. size.

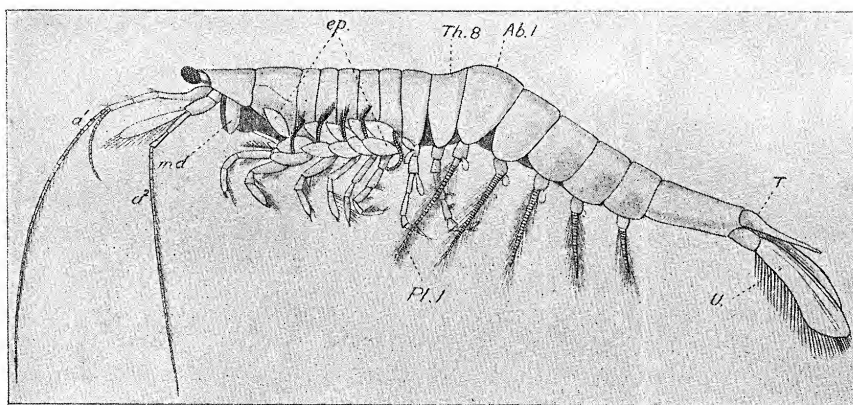


FIG. 2.—*Paranaspides lacustris*. $\times 4$. a^1 , 1st antenna; a^2 , 2nd antenna; $md.$, mandible; $ep.$, epipodites; $Th. 8$, 8th thoracic segment; $Ab. 1$, 1st abdominal segment; $Pl. 1$, 1st pleopod; T , telson; U , uropod.

is quite unknown from the northern parts of Australia or tropical Asia, so that it would appear to have reached Tasmania *via* South America. The entire absence of a lofty mountain range like the Andes, running north and south through the tropics of the eastern hemisphere, has precluded the possibility of a temperate fauna from the north reaching temperate Southern Australia by that route.]

Some Experiments made to Test the Action of Extract of Adrenal Cortex.

By S. G. SHATTOCK and C. G. SELIGMANN.*

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In a recent communication, in which we discussed the significance of secondary sexual characters in the Fowl, we suggested that certain of these characters, *e.g.*, the growth of spurs, "commonly regarded as essentially male, are not attributable to the function of the testicle alone, but possibly indicate the concurrent action of some other gland, perhaps the adrenal, seeing that not a few examples of precocious puberty in children have been found associated with adenomatous or carcinomatous growths of the adrenal gland."†

We selected the cortex for experiment because the new growths occurring in these cases consist of cortical tissue, and because so little is known of the physiological action of the cortex that there was nothing to negative the possibility referred to. The primary object of our experiments was to determine whether the injection of cortical extracts into young animals would hasten the appearance of secondary sexual characters, or exert any influence on the testicle. Since, however, there was no domestic animal smaller than the sheep, in which the male possesses well marked external secondary sexual characters, we were reduced to experiment on birds, selecting the common wild duck on account of the marked difference of plumage in the two sexes and the ease with which the bird can be kept in captivity.

Besides the gradual passage from its nestling to its adult winter and breeding plumage, the male of this species presents a seasonal change.

* The expenses of this research were defrayed by a grant from the Government Grant Committee of the Royal Society.

† "An Example of True Hermaphroditism in the Domestic Fowl," 'Trans. Path. Soc.,' vol. 57, 1906, p. 109. The reason for excluding the testicle in this connection is that the growth of spurs is not inhibited by castration of the young bird.

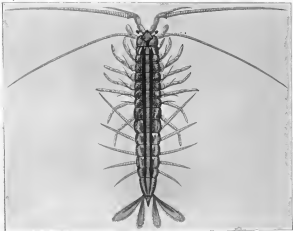


FIG. 1.—*Anaspides teimonica*. Nat. size.

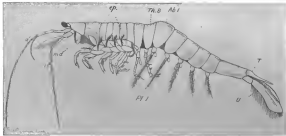


FIG. 2.—*Paranasaspides lacustris*. $\times 4$. σ^1 , 1st antenna; σ^2 , 2nd antenna; mand. , mandible; ep. , epipodites; Th. 8 , 8th thoracic segment; Ab. 1 , 1st abdominal segment; Pl. 1 , 1st pleopod; T. , telson; U. , uropod.